



AUTO-CRASH SAFETY RESEARCH

leading to

**OPTIMUM PROTECTION FOR AUTOMOBILE
OCCUPANTS**



AUTO-CRASH SAFETY RESEARCH

THE object of this report is to furnish a comprehensive description of research and development in auto-crash safety, and to provide a basis for the design of a device, and method of attachment, offering maximum crash safety to automobile passengers.

Being engaged in research, development and manufacturing in the field of aircraft safety, the American Seating Company, especially, has been appalled at the death toll on highways. In our extensive experience and continued efforts towards providing safer human restraining devices for high-speed aircraft, a program was initiated to safeguard occupants of automobiles during crash deceleration. The basic consideration is the protection of the human body with a device readily installed as accessory equipment in existing vehicles.

The general problem of automotive crash safety was found to be one of considerable complexity, from the mechanical as well as the

psychological standpoint. The initial point in the mechanical consideration was the study of motion characteristics of the human body in relation to the interior configuration of a vehicle, during crash conditions.

From results obtained by the Cornell Aeronautical Laboratory, Inc., it is possible to predict the initial general motion characteristic of the occupant of a vehicle during crash deceleration. Here it is emphasized that the majority of automobile accidents involve longitudinal deceleration, and that most deaths occur inside the car. For head-on impacts, there is a definite probable hit area for the occupant of the vehicle. (See Figure 1.)

At slower speeds, the driver will invariably receive a potentially injurious blow to the body, against the steering column. At higher magnitudes of impact, if not impaled by the steering post, he will receive a head blow against the windshield or the windshield molding.

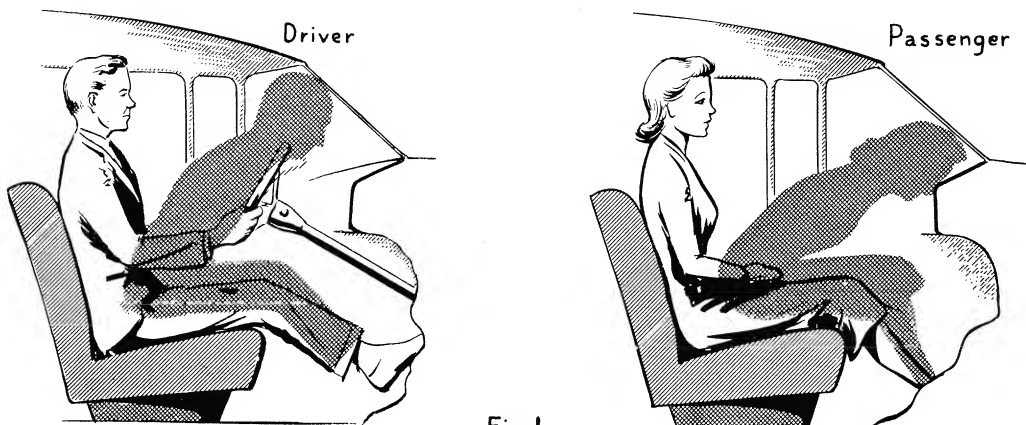


Fig. 1

Passenger Hazards

From the right-front seat, the occupant's head hits upper windshield, molding, or headliner. In subsequent action, the head carries forward to hit lower windshield and face hits the top of instrument panel.

The general motion characteristics of the rear-seat occupant are similar to those in the front seat. However, because fewer metallic objects exist in this compartment, the vulnerable hit potential is greatly reduced. This indicates that if the seats are adequately spaced, a lap belt of the aircraft type will offer adequate protection for the rear-seat occupant (see Figure 2). If the front seat is close, its top edge should be heavily padded.

The primary goal in automotive-crash safety has been to protect the occupant from objects within the vehicle. With a lap belt to control the action of the human body in the front seat during the crash, the motion is a combination of rectilinear and then angular rotation, about the hip joint. The average man, wearing a seat belt and using back muscles alone, cannot prevent impact blows to the head, during deceleration greater than approximately 4 g's.

Thus it is clear that a device restraining the upper body as well as the hips, and a suitable attachment structure that will absorb the energy of a crash, is essential.

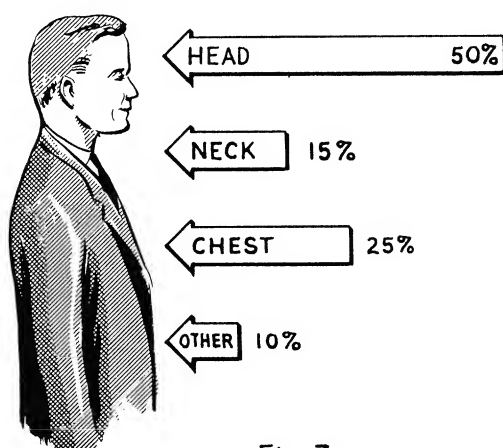


Fig. 3

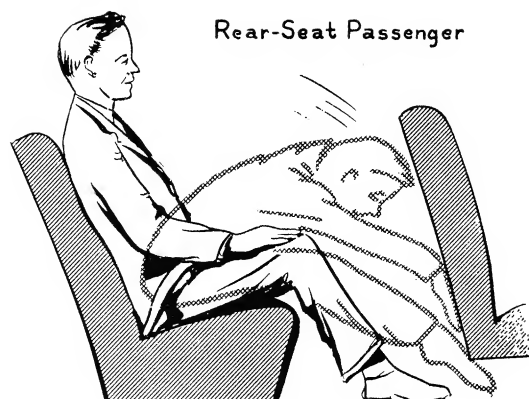


Fig. 2

Lessons from Aircraft Applications

Tests and actual applications in aircraft have established conclusive proof that combination shoulder straps and lap-belt restraint, if applied to automotive use, offer optimum protection — provided its potential life-saving ability be recognized by the general public.

The fantastic fact that approximately 40,000 Americans are killed, and 1,000,000 are injured, in auto accidents each year despite the admirable efforts of many agencies to reduce this toll, points to the important realization that the shoulder restraint proposed herein should receive all possible consideration from:

1. Automobile manufacturers — who should incorporate the shoulder-harness anchor frame as basic structure in the car.
2. All insurance, medical and other safety-conscious groups.
3. All agencies with means of educating the public in the life-saving benefits obtained from this device.

The graph in Figure 3 shows areas where the fatal injuries occur. These statistics substantiate the prediction that shoulder restraint could reduce the auto-crash death rate by as much as 80%!

Problems of Public Acceptance

Although research has established that, with the shoulder harness, a 60-mph impact can be survived by the occupant, it has been generally concluded that this device would not be accepted at this time by the general public, because:

1. The automobile has assumed a purpose with social significance; therefore the use of this device would require a good deal of psychological adjustment on the part of the general public.
2. Although the body motion characteristics in an automobile are similar to those in aircraft, the application of shoulder harness is somewhat different. The aircraft type of application, where the shoulder straps impose a load of approximately 3,000 pounds at the top of the seat back, would require major structural changes in auto seats. This appeared to be particularly difficult in automobiles with folding seat backs such as used in two-door sedans. (See Figure 4.)
3. The shoulder harness, hitherto used in automotive tests, was found too restricting to

the occupant's freedom of movement.

4. The fatigue element, created by the downward pull of shoulder straps attached to the seat back, was found to increase seriously in prolonged use. This appeared highly objectionable.
5. A very discouraging aspect developed during the impact tests: use of a shoulder harness resulted in possible whiplash injuries to the occupant's neck, on rebound action of the head. (See Figure 5). This led to a conclusion that head-rest type of protection would be essential in auto applications.
6. The inconvenience caused by shoulder straps in fastening over the body, and the cluttered appearance of the car when harness was not used, was also considered a significant objection.

It is apparent, from the foregoing summary, that the application of any shoulder-restraint device must, fundamentally, provide a satisfactory solution to the problems of each condition.

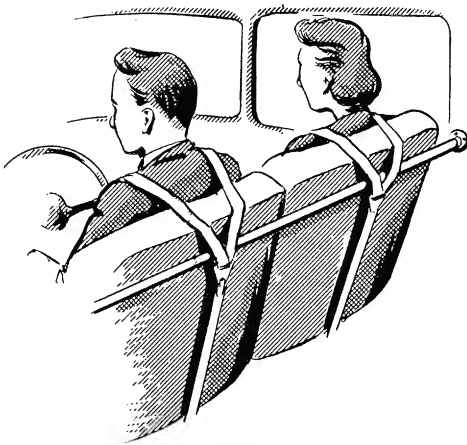


Fig. 4



Fig. 5

DESIGN DEVELOPMENT

WITH an eye toward the definite advantage of shoulder-type harnesses for automobile crash-safety application, American Seating Company engineers invented and developed a device (patent applied for) designed to provide the highest degree of protection in a manner

that would be acceptable to the automobile manufacturers as well as to the general public. This invention, for use in conjunction with the shoulder harness, in addition to the lap belt, is an improved and simplified automatic inertia-locking take-up reel. (See Figure 6.)

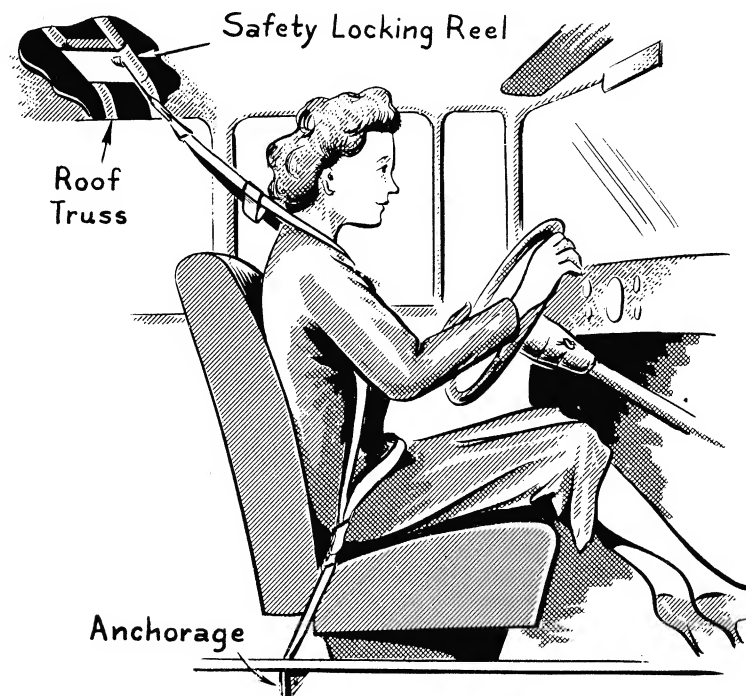


Fig. 6

The following is a summary of its essential design features:

1. This device permits a method of application that will overcome not only the mechanical problems described in the preceding analysis, but will greatly reduce the need for psychological adjustment.
2. Our objective is to provide such safety equipment, which in its operation is not dependent on the vehicle's seat but is secured to, and dependent on, the auto structure itself. The reel was designed specifically for auto use, to present a neat appearance, and to be efficient in its intended use. (See Figure 6.)

The reels are mounted between a pair of transverse members that span the vehicle's ceiling and are fastened to the strong structure supporting the roof. This serves as roof support and strengthens the vehicle's roof as a turnover reinforcement. A flexible restraining cable is provided, for each seat occupant, terminated to provide a strap for each shoulder. The lower ends of the shoulder-harness straps, which also include a lap belt as an integral part, pass through the seat-back junction, then securely fasten to the vehicle's frame below the floor.

3. The primary function of the reel is to provide the user with unrestricted freedom of movement during normal operations of the vehicle. Any slack in the harness cable is always taken up by the self-rewinding reel drum; however, any sudden deceleration, such as resulting from a crash, will automatically cause the reel to lock and prevent the occupants being thrown against potentially injurious objects, thus reducing possibility of injury or death. (See Figure 7.)

Although the reel prevents forward movement of the occupant after automatic locking, a ratcheting action will take up any slack as the occupant moves back. After the reel has been inertia-locked as described, it can be manually reset or cocked for further inertia operation, by a slight pull on a manual-reset control. The inertia-sensing lock element is activated by the pull-out velocity of the harness cable. Its response is thus multi-directional. The variety of impact conditions makes this multi-directional feature essential to maximum protection. The reel is set, at time of manufacture, to lock at the deceleration rate of 1 to 2 g's. However, provisions are made for a convenient adjustment, after installation, for other values.

4. The position of roof anchorage, above and behind the occupant's head, provides a slight upward and rearward tension (approximately 2 to 4 pounds), tending to relax muscular strain, thereby reducing the element of fatigue. This also alleviates



Fig. 7

downward impact forces which would impose an injurious compression load on the spine. The same arrangement offers a flexible head rest at the junction of the individual's shoulder straps, which adds to passenger comfort when relaxing in semi-reclining position.



Fig. 8

5. The most important function of the head rest, created by the junction of shoulder straps, is to eliminate whiplash injuries to the neck on forward impact deceleration as well as crash impacts from the rear of the vehicle. (See Figure 8.)



Fig. 9

6. The roof anchorage offers a method of stowing the harness neatly out of the way when not in use. The lower ends of each strap are easily and quickly connected and disconnected by means of bayonet-type fittings. (See Figure 9.)

The integral lap belt has an adjustment to allow for variation in body sizes of occupant. This overhead stowage also provides a simple and convenient manner of lowering the integrated harness over the occupant's body.

Conclusion

In analyzing the prevention of injury to an automobile occupant during crash deceleration, it seems logical that the answer should be based on natural physical laws pertaining to motion and energy. The occupant's motion must be suspended until the energy of the impact is dissipated or absorbed. The device developed by the American Seating Company, as described herein, is based on this logic.

The adaptation of this inertia-locking body-restrainer will not require any modification in

automobile design. Although the cost of this device will be higher in comparison with the lap belt alone, the benefit in human life and welfare should be worth any investment.

In conjunction with the great progress made by the automotive industry in increasing the strength of the automobile body, it is believed that this solution of occupant-protection presents an equally vital contribution towards the goal of increased safety on American highways.

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Dear Sir:

Thank you very much for your recent inquiry concerning the American Seating Inertia Locking Reel - shoulder harness device.

As pointed out in our advertisement, the device IS NOT NOW COMMERCIALY AVAILABLE, but it is currently undergoing thorough tests by Detroit automotive engineers for possible use in the future.

As the device now stands, it would take a complete restructuring of the roof of the car - and as you know, it takes much time for such changes to be incorporated in vehicles because of the complex machining, molding and tooling devices required. We are hopeful that tests justify use of our device in the near future.

I am attaching a brief pamphlet which may explain more in depth the use of American Seating Company's Inertia Locking Reel device. Although it was originally printed in 1957 as part of a research project, the fundamental details have changed very little. However, there would, undoubtedly, be some modification of this device - including the aforementioned roof structure - if it is accepted by the automotive industry.

I am sorry we cannot offer you any definite idea as to the date of availability for your automobile - or whether the device will be accepted by Detroit. We are hopeful that you will hear more about it from your local automobile dealer in the foreseeable future.

Thank you very much for your interest in American Seating Company.

Very truly yours,

J. W. Misamore
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Advertising & Public Relations Manager

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